The Anthrax Scare: Tips for Leaders

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THE RECENT ANTHRAX scares have provided something of a crash-course education in biological warfare. Soldiers who have trained for the traditional battlefield use of biological weapons now find themselves on unfamiliar ground due to the asymmetric and extremely low-technology nature of recent anthrax use. Meanwhile, the media have deluged the public with information and misinformation, much of it promulgated by self-appointed experts. This article addresses some of the more common concerns about using anthrax as a bioterror agent; specifically how key leaders can mitigate the risks of bioterror against soldiers, their families, and Department of the Army civilians. Although this article specifically addresses anthrax in a garrison environment, many of these principles can apply to other bioterror threats. This article uses only open-source, unclassified data in nontechnical terms to the extent possible.

It is useful to make three assumptions: that the terrorists' supply of anthrax spores is finite; that their lack of access to sophisticated battlefield dispersal methods means that anthrax dissemination will continue to occur through low-technology, surreptitious means; and that because of these constraints, the terrorists' objectives are limited to disrupting operations rather than causing mass casualties.

Defining the Problem

The vegetative (active) form of the bacteria *bacillus anthracis* causes anthrax. Anthrax occurs naturally in only a few isolated portions of the United States but is endemic in many developing nations. When not actually living inside an organism, anthrax exists in a dormant form called a spore. A tough protective coat allows these spores to survive in the soil for decades—one study found viable spores that were 200 years old.[1] These anthrax spores are processed for use in biological weapons.

Anthrax is not a communicable disease, and it cannot be transmitted from person to person in its active state. Anthrax spores can enter the body in one of three ways: by inhaling it into the lungs, by ingesting it into the digestive tract, or by contact with the skin, or cutaneous exposure. Inhalation is the preferred portal of entry for biowarfare and bioterrorism, as it is the most lethal and the most difficult to detect and treat. Anthrax ingested from contaminated objects or meat can be just as lethal but is much more easily defeated through sanitation and properly cooking food. Cutaneous anthrax is the least lethal of the three types of transmission—less than 5 percent of infections are fatal, given proper diagnosis and treatment, and only 20 percent are fatal even if untreated. Cutaneous anthrax infections occur when anthrax spores contact an open wound, typically when working with the hides or byproducts of infected animals or, in terms of biowarfare, by contact with contaminated objects or surfaces. Cutaneous anthrax theoretically can take place by direct blood-to-blood contact with infected persons, but this would be extremely rare and is preventable by practicing good hygiene.[2] Studies suggesting transmission by contact with biting flies in sub-Saharan Africa remain inconclusive.[3]

The body's immune system starts attacking anthrax spores once they enter the body; however, some spores may survive and migrate to the tracheobronchial lymph nodes. Thereafter follows an incubation period that varies from 1 to 60 days, depending on the number of spores involved and the route of entry into the body. Relatively high concentrations of aerosolized agent exposure from bioterror attacks may shorten this incubation time to 1 to 7 days, with symptoms present within 48 hours of exposure.

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After the incubation period, the spores assume the active bacterial form, multiply, and start producing toxins. These toxins actually cause the bleeding and destruction of internal organs located in the middle of the chest—hemorrhagic necrotizing mediastinitis—that are associated with the disease. This underscores why early detection and treatment are so critical in combating anthrax; antibiotics can kill the bacteria producing the toxins, but they do not remove the toxins.

There is a huge difference between anthrax exposure (contact with the spores) and anthrax infection (actually having the disease), although this distinction is often blurred during nontechnical discussions. In layman's terms, a useful analogy is comparing the anthrax spore and anthrax disease relationship with that of a single seed and a mature forest. Only in unusual circumstances would planting a single seed result in a mature forest, and likewise, only in an exceptional situation could a wayward inhaled spore produce the actual disease. The anthrax spore is similar to that ungerminated seed; even if it did become active in a suitable host, it generally takes many spores to produce a significant impact.

The exact number of spores needed to effect exposure and progress into an infection depends on many factors that remain a topic of debate. This is partially due to the rarity of naturally occurring inhalation anthrax. The general trend is that if you are in good health, your personal resistance may exceed the lethal inhaled dose. In fact, one study found that nonimmunized workers in animal hair-processing mills routinely inhaled 600 to 1,300 spores during an 8-hour shift without contracting the disease.[4] On the other hand, a few unlucky victims have died from much lower exposure. If you are not in good health or if your immune system is already weakened, you are much more likely to contract the disease at a lower total exposure. There are also indications that people over 25 and those with preexisting lung damage, including heavy smoking, may be more susceptible, but the jury is still out on establishing a threshold dose.

Recent events have caused scientists to examine the possibility that a chain of very low-probability events could result in inhalation anthrax infections by as few as 1 to 3 spores, but these, by definition, would be extremely rare instances. It is important to remember that the mere presence of a few anthrax spores in the area is not itself cause for alarm and that being treated with antibiotics following confirmed exposure is merely sensible.

Media reports commonly mention that inhaling 8,000 to 10,000 spores is required for infection to occur, but things are not quite that simple. The median inhaled dose is approximately 10,000 spores within a generally accepted range of 8,000 to 50,000 spores. In other words, 10,000 spores of proper size—1 to 5 microns—would theoretically be expected to infect about 50 percent of the members in any given population.[5] Being the median value, it also implies that there are some who will contract the disease with exposure to fewer spores and some whose tolerance to exposure is much higher; in other words, your mileage may vary. This is complicated by the fact that inhaled anthrax spores may remain viable in the lungs for up to

100 days, meaning that exposure may be somewhat cumulative.[6]

Anthrax is different from many other diseases because the relationship between dosage and lethality is not straightforward. The often-cited 8,000-spore figure does not represent a lower limit; in fact, as noted, a threshold dose has not been conclusively established. It is also important to remember that some of these figures were derived from biological warfare programs searching for the minimum dose that would reliably produce casualties, not produce incidental or fluke fatalities. Based on extremely rare occurrences, some scientists believe that only 1 to 2 spores could result in infection. It is unclear whether this is due to victim susceptibility, individual spore virulence, random probability, or a combination thereof. However, even this theory places the probability of infection at about .01 percent if the person is exposed at all.

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If we assume an average particle size of 3 microns—midway between the extremes of 1 to 5 microns—and a median dose of 10,000 spores, then a single teaspoon of pure anthrax spores theoretically contains about 593,052,048 lethal doses. But that assumes perfect dispersion in equal amounts to each of the 593,052,048 intended victims; real life is never quite that simple. Proper dispersion is critical to producing casualties. For example, anthrax bombs were designed for low-order explosions—enough to disperse the spores without generating sufficient heat to destroy them. Anthrax spray tanks achieve proper particle size by mixing them with larger volumes of carrier material and by using specially designed nozzles that are not the same as those that crop-dusters use. Pure anthrax spores require additives to keep them from clumping together into particles larger than the 5-micron maximum size for effective inhalation; this further decreases the number of theoretical doses in our teaspoon of anthrax example. In practical terms, then, it is not quite so easy to produce widespread casualties. Biowarfare experts assume an efficiency rate of 1 percent or less for a typical terrorist device; the envelope-delivered anthrax technique has thus far been statistically insignificant in producing casualties.

Symptoms of Infection

Complete technical descriptions of symptoms may be found in U.S. Army Field Manual 8-824, *Treatment of Biological Warfare Agent Casualties*.[7] In layman's terms, this is what to look for:

Inhalation anthrax symptoms are nonspecific and include fever, malaise, and fatigue. A nonproductive cough and vague chest discomfort may be present. There may be a short period of improvement of up to 3 days, followed by an abrupt onset of severe respiratory distress and possible meningitis. This is when the toxins begin to act; death usually occurs 24 to 36 hours later.

Ingestion anthrax may take one of two forms, depending on the location of the infection. Gastrointestinal anthrax has vague initial symptoms, including fever, anorexia, nausea, and vomiting. Abdominal pain, bloody vomiting, bloody diarrhea, and massive abdominal swelling can occur. Septic shock and death may follow. Oropharyngeal anthrax symptoms include a severe sore throat or a local oral or tonsillar ulcer, usually associated with fever, toxicity, and swelling of the neck.

Cutaneous anthrax initially looks like an insect bite or pimple that fills with liquid within 1 to 2 days. This vesicle ruptures to develop a painless lesion, approximately 0.5 to 2 inches in diameter, with a black-scabbed center. Because it is much easier to diagnose, it is more successfully treated and is rarely fatal. Note that the vesicle contains anthrax bacteria; avoid contact with its contents.

Assessing Threats

Force-protection and consequence-management planning begin with a threat assessment based on a unit's vulnerability and its value as a target. Leaders then begin to coordinate with the appropriate installation; the Department of Defense; and local, state, and federal agencies with technical response capabilities while training their personnel on proper reaction techniques.

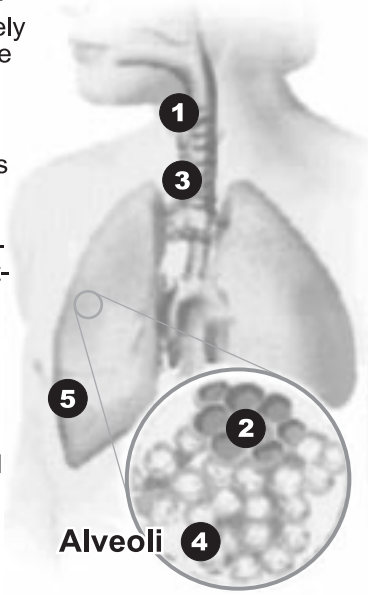
Although analyzing terrorists' capabilities and strategic goals is beyond the scope of this article, it is useful to make three assumptions: that the terrorists' supply of anthrax spores is finite; that their lack of access to sophisticated battlefield dispersal methods means that anthrax dissemination will continue to occur through low-technology, surreptitious means; and that because of these constraints, the terrorists' objectives are limited to disrupting operations rather than causing mass casualties.

Place the threat in perspective by honestly assessing your unit's value as a target. In general, the likelihood of being targeted will increase with one or more of the following: the target's criticality because

Inside an Anthrax Attack

The inhaled form of anthrax is rare and extremely deadly. Anthrax spores are dormant forms of the bacteria. When the spores are inhaled into the fertile environment of the lungs, they multiply.

1. If inhaled, large spores lodge in the upper respiratory tract where they are less dangerous.
2. Small spores that are between 1 and 5 microns penetrate the alveoli, the tiny sacks in the lung.
3. The immune system responds by destroying some spores and carrying others to lymph nodes in the chest.
4. In 1 to 60 days the inhaled spores in the lungs germinate and the bacteria multiplies, infecting chest tissue.
5. The bacteria produce toxins that enter the bloodstream, causing hemorrhaging, fluid collection, and tissue decay.



Symptoms

First stage can last from hours to a few days. The symptoms are flu-like: fever, coughing, weakness, and chest pains.

Second stage usually ends in death within several days.

Treatment

Antibiotics only prove helpful at the earliest stages of the disease because they fight the bacteria, not the toxins the bacteria produce.

Source: Monica Schoch-Spana, John Hopkins University; Jeff Bender, University of Minnesota; South Florida Sun-Sentinel.

of its mission or function, the probability of success, or the potential to exploit the publicity resulting from a successful attack. Conduct target analysis by putting your unit in the terrorists' shoes for a moment. Given a limited amount of anthrax and lacking the sophisticated means of large-area dispersal, would the terrorists target your unit? In most cases, the answer to this question is a resounding "No!"

This does not necessarily mean that your unit cannot be affected, but it does mean that any casualties are essentially the result of a bonus effect rather than one of intentional targeting. Leaders can use this information to drive the awareness or detection effort as well as the amount of organizational energy and resources that can justifiably be expended. Identifying the most critical functions and the systems that are most vulnerable to a bioterror attack will help the commander allocate force-protection resources and preventive, mitigating measures.

The level of acceptable risk will vary between units and individual personnel, but a desire to overprotect everything and everyone in the absence of a specific threat will squander limited manpower and medical material while inhibiting the unit's ability to perform its primary mission. Conducting a thorough threat analysis will allow the commander to conserve forces and materiel while not allowing terrorists to significantly degrade mission effectiveness.

Leaders can increase the effectiveness of response efforts and reduce false alarms by training troops and civilian personnel how to react to suspected

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anthrax situations. Following the first cases of anthrax, numerous false alarms strained the capabilities of first responders, law enforcement, and medical personnel. One false alarm occurred when someone reported dust particles in the air, not considering the possibility that the particles might be coming from the construction project going on above them.

If you encounter something suspicious, do not move it! There is a natural tendency to take the suspected item to a trusted peer or supervisor to ask for guidance. This increases the number of people potentially exposed to the suspected substance and thus the number of people who must be tested, decontaminated, and perhaps treated with antibiotics. It also greatly expands the number of rooms, or entire buildings, that require biosurveying and decontamination.

Instead, use a piece of cloth, plastic, or paper to cover the object and call for assistance. Close any

open windows or air ducts, close and mark the room to prevent others from entering, and call the designated first responder. Wash your hands and forearms with soap and hot water to limit the spread of any spores you may have encountered while handling the object. Wash your face, especially around your eyes, nose, and mouth, to ensure you do not inadvertently spread contamination.

Finally, prepare a list of names of everyone who was in the room and may have come in contact with the object; first responders will need this list. Facility managers should consider shutting down heating or air-conditioning systems to limit spreading anthrax spores through air ducts.

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Depending on the unique situation at your location, either garrison-level first responders or medical personnel will conduct a field test for presumptive presence or absence of anthrax using various hand-held antibody tests. The test kits resemble a home-pregnancy test kit and are almost as easy to use, but they sometimes yield false positive readings due to nonsite-specific binding to similar bacterial strains. A positive reading from these detector kits should always be followed up with laboratory confirmation.

Only qualified medical personnel can decide to administer antibiotics. Because of anthrax spores' short incubation period, lab test results may not be available until after a patient's condition is critical. Therefore, medical personnel generally prescribe an appropriate antibiotic regimen, then either continue or discontinue it based on the conclusive lab results.

Certain high-risk personnel, such as those identified in the force-protection analysis, may require additional protection. These may include first responders—firemen, hazardous materials (HAZMAT) handlers, or law enforcement personnel—health care providers, military postal unit personnel, or high-profile individuals. Force protection for these personnel may be through using engineering controls, administrative controls, housekeeping controls, or personal protective equipment (PPE).

Engineering controls ensure that facilities and machinery minimize the aerosolization and spread of contaminants. These include heating ventilation and air-conditioning design and measures to reduce air turbulence near high-speed mail-sorting machinery. Some of these will require long-term fixes. Administrative controls reduce the probability of exposure by limiting the number of personnel permitted into likely exposure sites, especially enclosed rooms. Examples include reducing the number of workers required and eliminating visitors or excess support personnel.

Housekeeping controls limit the physical spread of contamination. Examples are using a high-efficiency particulate air filter-equipped vacuum cleaner or wet sweeping, instead of dry sweeping or dusting, to minimize the number of airborne spores in a high-threat room. PPE may be used for personnel whose normal duties place them at an elevated risk for anthrax spore exposure. For these personnel, leaders might consider implementing wearing long-sleeved clothing, using impermeable gloves with a cotton liner to reduce skin irritation or rash, or issuing Occupational Safety and Health Administration-approved masks and filters. A properly fitted M40-series protective mask provides more than adequate protection against aerosolized anthrax. Washing with soap and water after possible exposure to contaminants is also recommended. HAZMAT personnel should follow established regulations.[8]

Both human and animal remains can pose infection hazards to those who handle them. Using appropriate protective clothing and observing Control of Substances Hazardous to Health regulations will protect against infection hazards.[9] Be aware that organisms that die of anthrax release massive quantities of spores into the soil that can remain for decades before being ingested again. Burying animal carcasses is of little use in disrupting transmission since earthworms can carry spores back to the surface.[10] Those who handle and dispose of biologically contaminated remains must be cognizant of potential secondary transmission hazards. Current evidence indicates that complete incineration is required to sterilize remains contaminated with spore-forming bacteria.[11]

Facts About Anthrax

As has been widely reported in the media, anthrax is considered to be noncontagious; that is, the active bacteria are not passed directly from one infected person to another. Anthrax is transmitted via

inactive anthrax spores that must enter the body and undergo incubation before becoming active bacteria. It is theoretically possible to contract cutaneous anthrax if a person with an open wound comes in contact with contaminated body fluids, but common sanitary measures are effective in preventing this mode of transmission.

The notion that using a steam iron on a suspect envelope will neutralize spores probably started with mentioning that spores could be destroyed by steam sterilization or burning. Although it has been reported that boiling at 100 degrees Celsius for 30 minutes will destroy anthrax spores, using mom's steam iron does not quite cut it.[12]

Despite the vernacular use of the term "nuking" some dinner, microwave ovens cook food by exciting, thus heating, water molecules, not by using ionizing radiation. Placing suspicious mail or packages in a microwave oven will not destroy anthrax spores by radiation; on the contrary, it could cause combustion.[13] Although the fire might destroy any anthrax present, it would also destroy the letter and possibly the microwave oven—obviously not the best course of action. Research into using ionizing radiation to destroy bacterial spores, using *bacillus pumilus*, a bacteria commonly used for tests, indicates that a 140,000- to 400,000-cGy radiation total dose would be required to destroy 90 percent of the spores present.[14] By comparison, unclassified nuclear planning doctrine cites 18,000 cGy to produce 100-percent human incapacitation within 5 minutes and 100-percent fatalities within 15 hours. The level of radiation needed to destroy anthrax spores would require a small reactor or an accelerator, not a kitchen appliance.

Disinfecting contaminated articles may be accomplished using a 0.05-percent hypochlorite solution, or 1 tablespoon of bleach per gallon of water. It is important to note that the bleach method is for use with contaminated articles and surfaces, not on human skin. Use soap and water if skin contamination is suspected.

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Using any antibiotic without an identified need is unwise from a medical standpoint. Indiscriminately using limited-availability antibiotics may lead to a critical shortage for those who actually need it. Most modern antibiotics are effective against anthrax, including penicillin, usually administered intravenously; vancomycin; tetracycline; and others.[15] There are drawbacks to preemptive penicillin use, regarding the length of treatment.

Recent events have produced a great deal of information and misinformation about anthrax. Leaders can use the information in this article to inform and protect their personnel while continuing their missions. By overcoming fear, conserving critical resources, and focusing on primary missions, leaders will deny their opponents' victory. Then we can concentrate on collectively contributing to destroying our enemies. ***MR***

NOTES

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